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AUTOMATIC MULTIPLE POINT SYSTEM FOR MEASURING MICROPHYSICAL CHARACTERISTICS OF FOG IN EXPERIMENTAL INSTALLATIONS

By

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13. ABSTRACT

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As to the second type of apparatus used in the installations, they concern a photoelectric meter of aerosol particles "Aelita," similar to the device worked out by A. G. Lactionov for laboratories and aircraft measurings. Their work is based on diffusion of light by aerosol particles, at which time the amount of light dispersed by aerosol particles depends on its size. Transforming a flow of light into electric current in the photoreceiver, one can, with the help of electronic arrangement, measure concentration and spectrum of the aerosol being studied.

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AUTHOR: Yu. I. Moiseyenko and G. I. Shchelchkov

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NOTICE

AUTOMATIC MULTIPLE POINT SYSTEM FOR MEASURING MICROPHYSICAL CHARACTERISTICS OF FOG IN EXPERIMENTAL INSTALLATIONS

Introduction

During the last years, both in national and foreign communications, a great deal of attention was given to automation of scientific experiments.

The present article is devoted to the automation of measuring the proportions of aerosol particles, their concentration and the character of distribution according to size, this in experimental installations of the Institute of applied physics. To determine the microphysical character of fogs created in these, two type of apparatus were used. The first type consists of an aerosol trap (lovushka) in which the cloud particles are caught, counting on inert settling; on a glass sheet with a special cover, after which these are photographed through a microscope, then calculated. The main inconvenience of this method are the time consuming operations for the preparation of traps for the processing of measuring the results for a relatively small quantity of information obtained. Automation of some operations in regard of work with the traps in an aerosol chamber was accomplished by V.V. Smirnov.

As to the second type of apparatus used in the installations, they concern a photoelectric meter of aerosol particles "Aelita", similar to the device worked out by A.G. Lactionov for laboratories and aircraft measurings. Their work is based on diffusion of light by aerosol particles, at which time the amount of light dispersed by aerosol particles depends on its size. Transforming a flow of light into electric current in the photoreceiver, one can, with the help of electronic arrangement, measure concentration and spectrum of the aerosol being studied.

With the introduction in exploitation of experimental installation of a large volume (up to 3200 m3), in which fog is created by means of steaming or adiabatic spreading, the necessity to measure spectrum and drop concentration of the fog in a number of areas inside the installation. For this purpose a five point automatic system has been worked out, using photoelectric devices as registers. The aerosol chamber was equipped with such apparatus (five points) as well as with two termobarochambers (with two points in each). This system allows up to six measurings of spectrum per minute and the noting down in figures (numbers) on a paper tape.

A specially designed seven channel integral amplitudinal analysator, automatically plugged in in each register of the system serves as the electronic installation for the entire system.

Inasmuch as the system allows to obtain a great deal of information about the concentration of fog particles and spectra of their distribution according to size, it is possible with its help to follow up the character of fog parameter alterations in the various areas of the installation from the moment of its formation up to its full dispersion.

Knowing the spectra of distribution, it is easily possible to calculate, using the method suggested by L.M. Levine, all basic microstructural fog characteristics and to find their changes in time. All measurings conducted up to the present were limited by measurement diapason 2 + mk in diameter, although, in principle, the lower (porog : threshold ?) of the register, applied in the system, may be lowered up to 0,2 mk . The greatest fog concentrations, measured by this system, were limited to 3000 cm. particles. More detailed information about register parameters and measurements errors are given in (1) and (2).

Block-schema of the system

The block-schema of the system is shown on draw. 1 . Photoelectric devices applied in the system as registers (D1+ D5), are described in (1). Each register has its own feeding block (BP-1 + BP5), which insures a constant stress or tension 8 in the photometric lamp of the register and in the airblower motor. The feeding of amplifiers and cathode repeaters, disposed in the register head, is insured by a source of anode and incandescent tension (IANN), which is common for all registers. A source of high tension (IVN) serves to feed photoelectronic multipliers.

Impulses of positive polarity from the registers, proportional with the amplitude measuremenets of aerosol particles, act on the signal commutator (KS) which affects on the analysis of the corresponding signal from each register. Analysis and registration of data are carried out by means of a seven channel integral amplitude analysator and an electro-directed printing machine. Channel construction of analysators is uniform. Their differentiation lies only in the number of discharges.

Impulses entering amplifiers amplify and through the cathode repeater in the negative polarity get on all seven comparison schemes, each of these having its own determined level of achievement (srabativanya : working in harmony). Levels are determined by the operator with the help of (zadatchika ?) of supporting tensions (ZON) after receiving graduated curves of all registers plugged into the system.

As the various types of registers, due to their parameter dispersion forming their element have various functional dependencies of amplitude of exit impulses from the size (diameter) of aerosol particles U =f(d), then to obtain uniform diameter intervals of particles between the channels, it is necessary

to have various levels of achievement for various registers. Therefore the (zadatchik) of supporting tensions plug in five level schemes (according to the number of registers) each of which consists of seven leveling chains, insuring smooth regulation of apparatus achievement regarding the comparison of each channel; With the help of the commutator of supporting tensions (KON) these chains are trans-plugged in the process of work in a synchronic manner with the trans-plugging of working registers.

The level of achievement of each subsequent (next) channel is higher than the level of the previous one . At the time of working out the scheme of comparison at its exit appears the impulse of positive polarity. From the exit of each comparison scheme impulses fall separately, each according to its channel, where they are amplified, after which they are formulated by the formulator (F) and fall into the electronic meter. Optical indicators (OI) are used for the visual control of channel work.

Readings of meters through double-tenth denumerator (deshifrator) are registered in figures by using lamps of the IN-1 type, and also by means of a step searcher (?) = (shagovoy iskatel') (SH-1), four cathode repeaters (KP) and a diode-relay deshifrator (decipharor ?), installed simultaneously in a EYM-23 machine, and are written down on a paper tape in the machine.

The master console (blok upravleniya) by means of the analyser works out all necessary commands for the control of the recording part of the system. Both by manual and automatic control the time of measuring by one register consists of three cycles : "measuring", "printing" and "indication". After giving the command "print" the order of going through of control commands is the same in both cases. On the chain "print" plugs in the electroengine of the typewriter. Simultaneously with this on the chain "signal in-out" the entrances of the channel amplifiers close by an electronic key, so that impulses on their entrance do not go through. With the use of a cam system and typewriter contacts on the chain "synchronisation" is carried out the control by means of (shagovoy iskatel' =? step searcher) and solenoid printing. After the printing of one line is given the command : "stop-print". At the end of the predetermined time, is given the command "break" (sbros) as a result of which the indications of the counters of all channels turn to zero; as to the chain "signal in-out" the plug in of amplifiers open and the "measuring" cycle begins. The time of the cycle"print" is constant and equal to 7,5 sec. The time of "measuring" cycle and "indication" may be regulated from 0 up to 20 seconds.

A control generator is used to check the registering parts of the system prior to starting measuring.

Automation block insures the handling of all operations by commutation of entry signals from the registers corresponding

to each register of the threshold circuit, realizes the changing of the print color; sets in motion register motors at the time of indication and the dialling of information and unplugs them upon completion of setting; sets up the light showing the number of the register plugged in at a given time. Besides, in the block circuit are foreseen manual control by way of step (shagovie) searchers, who plug over the outputs for registers and threshold circuits, manual unplugging of air blowers and cable signals of any register as well as plugging over of color printing on any of the registers.

The system can work with any selected number of registers from one to five. Upon obtaining of data and registration of the last register, the circuit automatically plugs in the first register.

Thus, the system works automatically during the whole experiment. The only thing required from the operator is to plug in the circuit when the fog forms and plug it off after its full dispersion.

BRIEF DESCRIPTION OF THE SEPARATE PARTS OF THE SYSTEM.

1 - Photoreceiver circuit.

The basic photoelectric devices used in the given system consist of three functional circuits :

a) optical circuit for the formation of working light volume;

b) the circuit (prososa) of aerosol through working light volume;

c) photoreceiver for the transformation of dispersing particles from light pulses into electnic pulses.

The device is explained in detail in (1), therefore we shall limit ourselves only on the schema of the photoreceiver, inasmuch as it differs .

Draw. 2

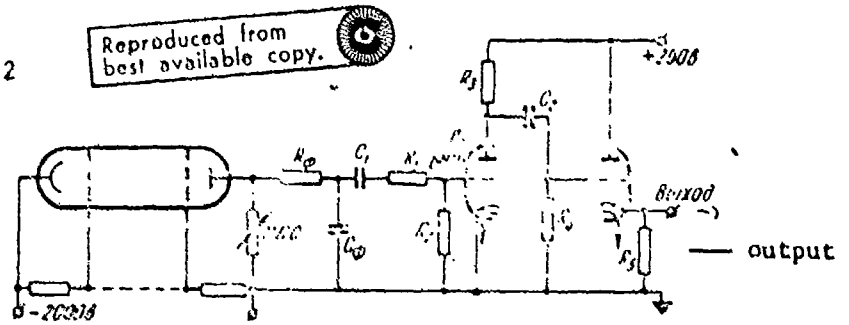


Рис. 2. Фотоприемник Photoreceiver

The photoreceiver (draw.2) includes a photoelectronic multiplier of the FEU-15A-type and a preamplifier with a cathode repeater on a 6N3P bulb (valve). The light current; diffused by aerosol particle, falls on FEU cathode . On the anode load FEU gives out the negative pulse of tension, the size of which upon

resistance of the anode chain and upon work on linear participation of light characteristic FEU proportional to the square diameter of particle.This square dependency lowers the dynamic diapason of dimensions measured by devices. For the purpose of widening the diapason in the anode chain FEU a nonlinear semiconductor resistance is plugged in. Chain parameters C_1 - R_1-R_2 are selected for each register in relation to parameters of its elements (brightness of illuminator, character of the light field, internal sensitivity of FEU etc;) and from the necessary diapason amplitude for the selected analyzer. The output pulse is removed from resistance R_5 of the cathode repeater and by (koakcual'nomu) cable of a length going up to 50 m. from the point of measurement is passed on to the laboratory for analysis.

2 - CONTROL GENERATOR

The control generator is constructed according to the diagram of a selfpropelled multivibrator on a 6N3P lamp (valve). The duration of generating pulses 60 mksek. Frequency repetition (modulation ?) near 3 kgtz) . Aplitude of output pulses of positive polarity is regulated by potentiometer R_6 . The generator is plugged in the input of the aplifier by connector P. During the experiment the connector P is connected to the input amplifier of the output cable with the signal commutator. (draw. 3)

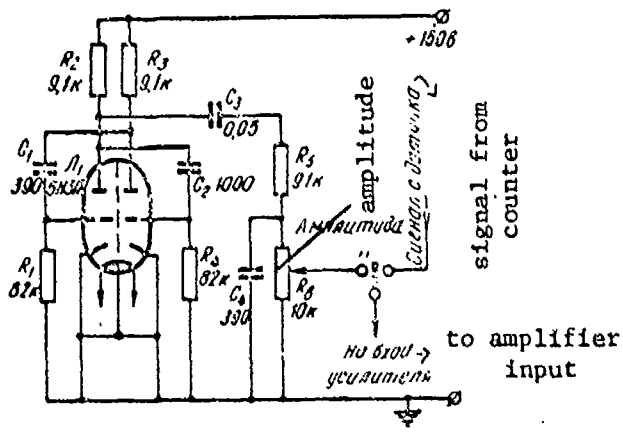


Рис. 3. Контрольный генератор

3 - AMPLIFIER and CATHODE REPEATER.

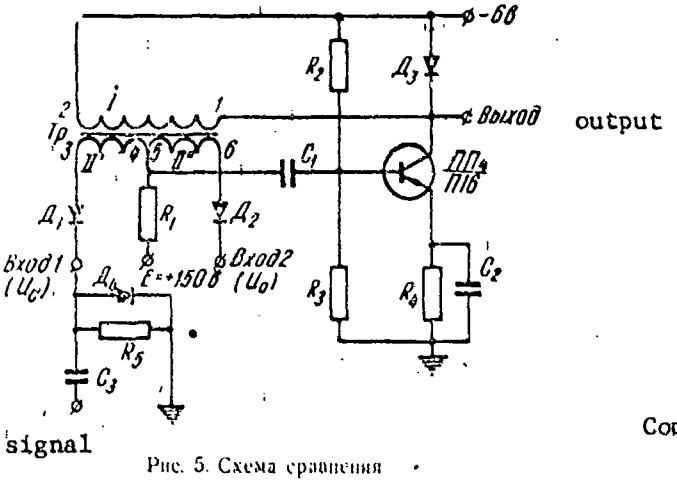
The amplifier (draw.4) is put together according to the usual plan of an amplifier on resistances on bulbs 6N6P and 6DZ5P It has a stepped (1:2) regulation of amplification with the help of connector P and (plavnaya) reostat R_3 .

The link between the amplifier and the circuit of comparison of the analyzer is done through the cathode repeater, collected on the lamp 6N6P, of which both halfs are plugged in in a parallel fashion.

see draw. 4 attached

4 - COMPARISON CIRCUIT

The comparison circuit is in fact a balancing diodo-regenerative comparator, built on transistor and silicon diodes. Comparator plan (draw.5) is made out of comparison circuit, constructed on diodes D_1 and D_2 and blocking generator on PP1 (P16) transistor.



Draw. 5
Comparison plan (circuit)

Рис. 5. Схема сравнения

The comparator works in the following manner. Before tension signal U_c applied on input 1 reaches supporting level U_0, diode D_2 is open. Its current is determined by the tension sum U_0 and E and resistance R_1. The plugging in of winding II" of the transformer is such that the blocking generator does not function (return connection is negative) . Diode D_1 is closed off. At the moment of comparison ($U_c = U_0$) diode D_1 opens and closes the circuit of winding II'; this makes diod D_2 to close and the blocking-generator creates a short pulse, which is in fact the output pulse of the comparator. Diode D_2 remains closed up to the time when the process of discharge of condensator C_1 is completed (the process of reinstating the original condition of the comparator). The comparator will be sensitive to the next pulse only after the reinstatement of the initial condition.

Elements R_2 R_3 R_4 and C_2 form the usual circuit of the temperature stabilisation of the working part of the transistor. Diode D_3 shunts the transformer and prevents (demfruyet) pulse excitation of waves in it. Elements D_4 and R_5 have as purpose the restoration of constant composer (zero) . Collecting feeding E_k = - 6 v is removed from the special divider of stabilized tension -150 v in the analyzer. The setting of level U_0 is set by potentiometers of the threshold circuits in the (zadachnik) of the threshold tensions . The sensitivity of the comparator is no less than 20 mv. Pulses of the positive polarity, from the comparators outputs fall on doublecascade channel amplifiers.

5 - CHANNEL AMPLIFIER WITH OPTICAL INDICATOR (drw.6)

The channel amplifier is put together on a double triode 6N3P and represents a doublecascade amplifier on resistances. The positive pulse with the corresponding comparison circuit enters on the net of the left hand side half of the valve. From the right hand side half anode the amplified pulse of the positive polarity supplies the (formirovatel').

An optical indicator selected on valve 6E1P is plugged in to the left anode of valve 6N3P. The optical indicator served for visual control of comparators work and is used at the time of installation of thresholds (srabativanya) with use of control generator.

draw.6

Channel amplifier with visual indicator.

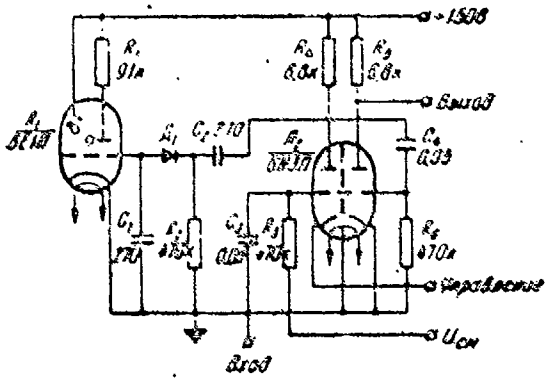


Рис 6. Канальный усилитель с оптическим индикатором

draw.7

(formirovatel')

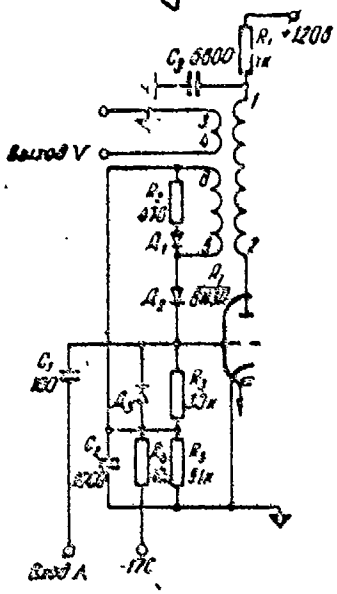


Рис 7. Формирователь

6 - (formirovatel') on draw.7 is selected on one half of valve 6N3P according to the circuit of the braked (impeded) blocking-generator. On the input of the (formirovatel') from the channel amplifier is applied a pulse with an amplitude of no less than 35 v. Output pulses of the negative polarityare removed from the separate winding of the transformer blocking-generator and fall (are applied) on the input to the first decade of the meter.

7 - METER AND REGISTRATION ELEMENTS.

The accounting of formed pulses in the channels is carried out in tens (decade), selected on valves 6N3P. Coef ficient of the counting, equal to ten, is obtained by introduction of direct (straight) and obliaue link . To the left anodes of valves of (triggernikh yacheek) are plugged in deshifrators of figure (numeral) indication and diodo-relay deshiffrator machine EUM 23 (drawing 8) . For this purpose a reverse double functioning, for which to the nero state of triggers correspond high potentials on valve anodes (left hand side valves of triggers are closed). Triggers are started with negative pulses of 30 ÷ 50 v amplitude and a front steepness not exceeding 1 mksek. The speed of ten count is 200 kgc.

The decipheror of numeral indication is done on transistors of the P26 type, into which collector chains are plugged in relays of the RES 22 type. A valve IN 1 is used for the indicator itself.

Diode-relaying decipher for print is set on D226 diodes and type RKM 1 relays. Relay contacts commutate solenoid print. Mechanical carriage return is replaced by an electric one.

8 - CONTROL CONSOLE BY ANALYZER

Electric circuit of control console by analyzer allows to maintain or set for the necessary time of exposition (selection of information) using an electronic relay; the time of entire cycle and handles the work of the printing machine and other elements of the analyzer. On the front panel of the block are located the control elements of measuring time and indications, signal switch and the switch to switch over the work regime (manual or automatic), knob of break off, knob for starting printing and valves for signal indication, measuring and printing.

9 - AUTOMATION AND COMMUTATION ELEMENTS .

The basic circuit of the automation block, of the signal commutator, of the (zadatchik problem setter) and of the commutator of supporting tensions is shown on draw. 9 . As was already indicated above, the circuit does all operations automatically, this during the process of measuring the spectrum and drop concentration during the lifespan of the artificial cloud this for any number of working registers at any given time.

Let us examine the working of the circuit during the automatic cycle . If the measuring is effectuated by all five registers, then B_1 and B_7 are switched off, $B_8 \div B_{12}$ are on, and (pereklyuchatel') switches $P_1 \div P_5$ are set at position 1.

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The automatic cycle is set by relay P9 of the analyzer. Feeding on winding of relay P9 is applied during printing time. At that moment, contact of relay P9 which is usually off is switched on and the chain of winding on relay P8 is insured. The capacity of C4 is charged through the normally closed contact of relay P8. At the end of printing (srabativayet) relay P8 and the capacity C4 discharges through winding of relay P7. Through contacts of this relay are given pulses of tension on windings of step searchers SHI 1 and SHI 2 which make one step. At that time, SHI 1 plugs in to the input of the amplifier the signal cable of the next register, switches on the motor of its airvent and the corresponding bulb signal on the deck. The step searcher SHI 2 switches on the corresponding threshold circuit. During the time of indication (t 2 sec;) a flow of aerosol is established through the capillar of the register. After this, the circuit of the analyzer is transfered to the selection of information by electronic relay in the control console by analyzer. Upon termination of selection relay P9 is worked off, removing current from relay P8 winding. During this, the capacity C4 is transferred to charge and feeding chain of the motor for the air blower is switched off. The entire cycle is repeated with the next register.

Let us assume that the secondregister must be excluded. To achieve this, it is necessary to switch off B2, switch over P2, put in position 2 and close off the switchoff B9. As this takes place on the corresponding lamel of the threshold searchers is applied tension 24v, these through their contacts jump over the position corresponding to the excepted register and immediately switch on to the next register (working register).

To render the work easier; one of the resiters' showings are registered by a red light. The selection of the register is performed by a galette switchover GP. The circuit of color change of print works in the following manner: through the lamels of the stepped searcher SHI 1 corresponding to the selected register and through the galette switchover; feeding is provided for winding of relay P6. The capacity of C2, charged up to tension 24v is plugged on to the electromagnet EM and is discharged through its winding. The electromagnet moves the tape leader and through it - a two color tape. The capacity of C3 begins to get charged. Upon completion of cycle for print, relay P6 loses current (power), switching the charged capacity C3 to the electromagnet EM2, which changes the tape on to another color.

On plan (draw.9) are shown also the levelling chains for all channels of the first register. Chain circuits for the remaining registers are analogous to those shown. The capacity of CI and C5 are used for putting out the sparks in the contacts of stepped searchers.

CONCLUSION

Prolonged experimentation of the system in the laboratory of experimental installations of the Institute of applied geophysics branch indicated the efficiency of the system. A series of experiments took place during that time with the purpose of clarifying the possibilities of producing models of various cloud processes in chambers. During the time of testing and when the system was idle, a comparison of various models applied in the system of photoelectric registers was studied. The comparison indicated that different registers give coincidental results just as much for the concentration of particles of aerosol as for the character of spectrum distribution within the limits of error for the given concentration .

Comparison of metereological distance of visibility, calculated out of spectrum measurements, with the distance of visibility, measured by optical devices, partly by a one channel photometer of direct action and a laser, the length of the ray wave which is located in the visible area of the spectrum ; a satisfactory coincidence was also shown. Comparison of wave size, calculated out of the shown system with waves measured according to the Zaytzev system indicated that the greatest difference in the results of both systems lies within the limits of 15 % .

RESULTS

1 - An automatic five point system for measuring concentration and spectrum of concentration of fog drops, artificially created in the experimental installations of the IAG branch has been studied, built and tested ; it also has been put into exploitation .

2 Prolonged testing and comparison with other devices prove reliability of results obtained with the described system.

3 - The system can be used to carry out numerous experiments in chambers needing to obtain a great deal of information about spectrum distribution of fog drops according to size and concentration in the entire volume of the chamber, which cannot be done with isolated instruments .

In conclusion, authors express their sincere appreciation to all laboratory workers who took part in the fulfilment of the given work.

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Inst: of Appl. Geophysics publication - issue 7-1967.

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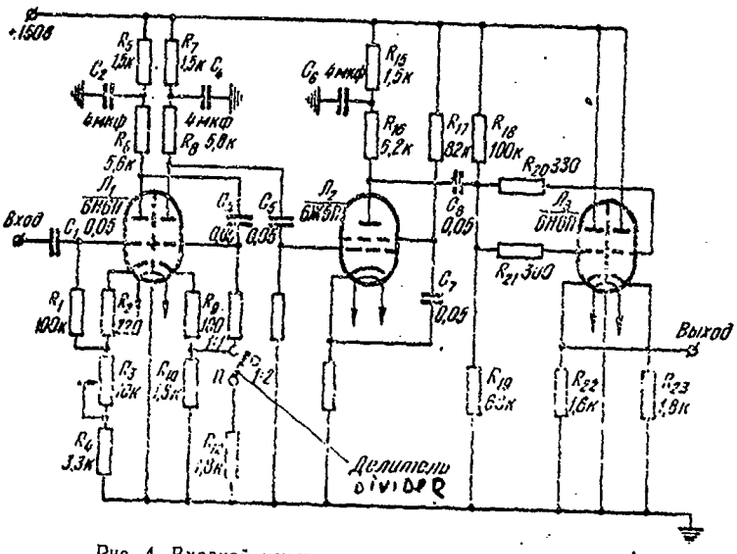
Draw. 4



input

Output

Рис. 4. Входной усилитель с катодным повторителем

Input amplifier with cathode repeater.

Draw. 8

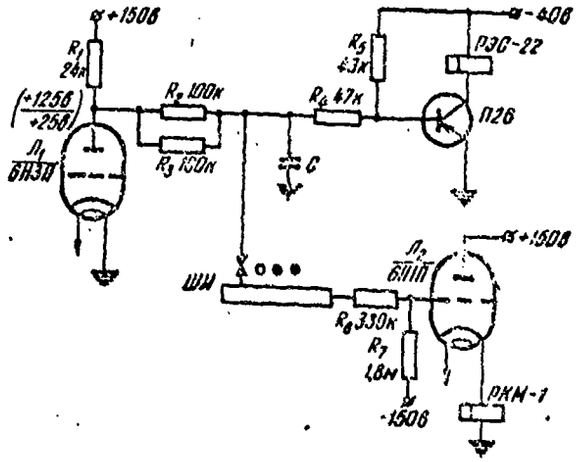


Рис. 8. Упрощенная схема связи анода триггера с дешифратором цифровой индикации и с дешифратором печати

Simplified circuit of the link of the trigger anode with the decipher of the numeral indication and with the print decipher.

DRAW. 9

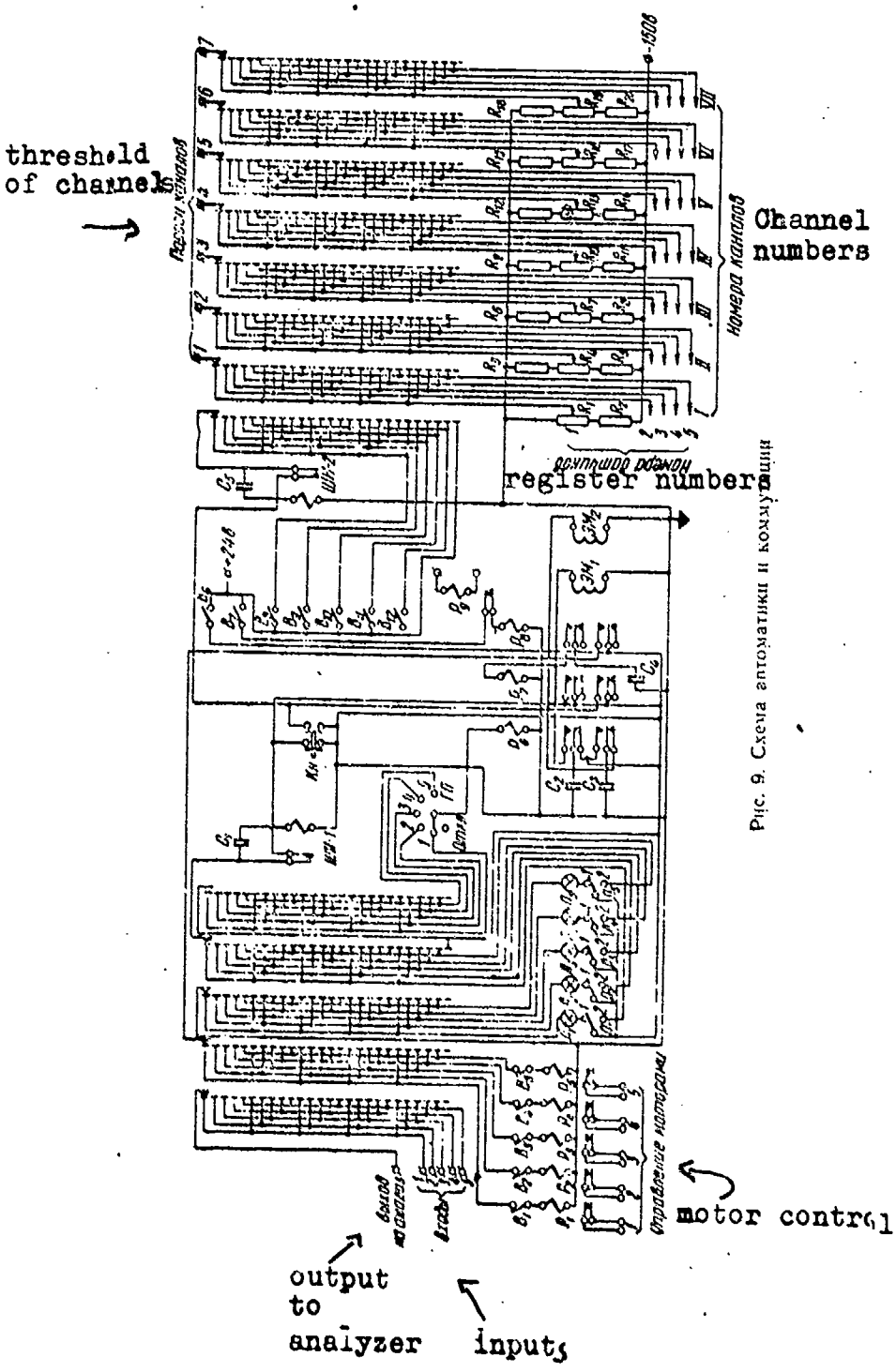


Рис. 9. Схема автоматики и коммутации

Automation and Commutation Circuit

NOT CLEAR ENOUGH XEROX FOR ACCURATE TRANSLATION

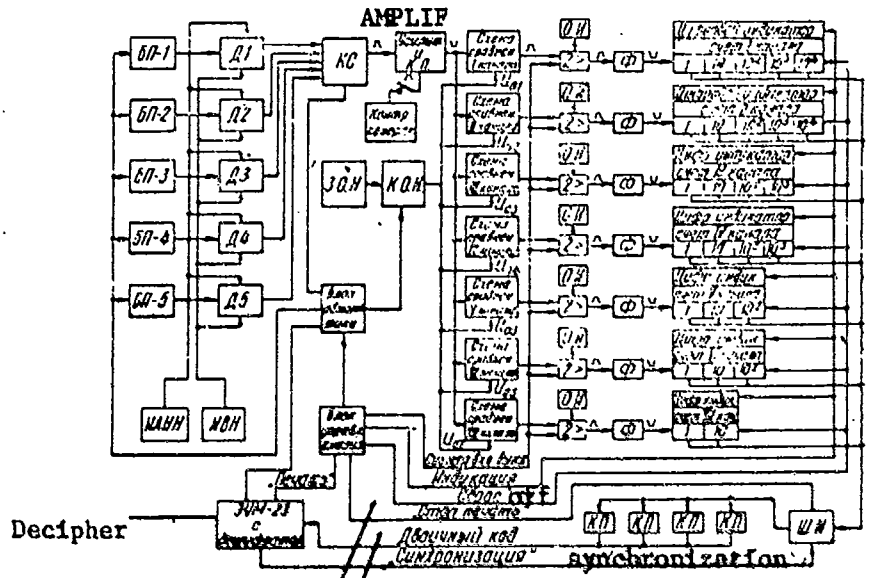


Рис. 1. Блок-схема системы

Draw. 1. Schema of the system

Double or two way functioning

Stop Print